

# Converting Technical Content to Training Material

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**Abstract:** This paper provides the basis for an interactive mini tutorial and covers how to convert technical content to training materials. It includes: defining the audience, writing Learning Objectives, designing content and activities to achieve objectives, engaging participants in learning activities using adult learning methods, and assessing the learning event to determine whether objectives have been met. Examples are provided from NCSL International<sup>1</sup> resources. The instructional approach in this paper covers the Analysis, Design, and Development phases of the ADDIE instructional system development (ISD) model; due to time constraints, it will only briefly touch on the Implementation and Evaluation phases. The paper integrates concepts from Bloom's Taxonomy and criteria from the ANSI/IACET<sup>2</sup> standard for offering continuing education units as an Authorized Provider.

**Learning Objectives:** Given the handouts and practical experience during the tutorial session, participants will be able to successfully:

1. Identify the phases of the ADDIE instructional design model;
2. Define the appropriate audience for training content;
3. Identify and Create well-written Learning Objectives;
4. Give examples of Activities that will engage adult participants and achieve Learning Objectives; and
5. Identify appropriate Assessment methods to determine whether Learning Objectives have been met.

## Background

The NCSLI Strategic Plan has identified an effort to create training resources to match with NCSLI publications as they are created and updated. NCSLI is also seeking to gain compliance with the International Association for Continuing Education and Training (ANSI/IACET) criteria for offering Authorized Provider Continuing Education Units (CEUs) to ensure continual improvement and professional training approaches in our metrology training. This session will use resources from three



**Figure 1. Sample ANSI/IACET logo which we could apply to NCSLI content if we were an Authorized Provider.**

<sup>1</sup> NCSL International (also known as National Conference of Standards Laboratories, International).

<sup>2</sup> American National Standards Institute, International Association for Continuing Education and Training (ANSI/IACET). <http://www.iacet.org>, 2010.

new NCSLI publications and their associated conference/section meeting presentations as *Application* examples throughout this paper. These publications include Recommended Practice (RP) 3, “*Calibration Procedures*”, Recommended Practice (RP) 20, “*Metrology Laboratory Workforce Planning*” and the “*Metrology Human Resource Handbook*” (HR Handbook).

The ANSI/IACET criteria require organizations to use a systematic design and development process for developing all training materials. Most professional instructional designers follow some type of model, probably the most common of which is the ADDIE instructional system development (ISD) process. ADDIE refers to the Analysis, Design, Development, Implementation, and Evaluation phases of the ISD process. One of the unique features of the metrology community is that instructors are often subject matter experts (SMEs) without a formal background in ISD. Our overall goal with this paper and mini-tutorial is to provide guidance to the NCSLI technical committee members who are SMEs to develop training resources that follow a standardized practice, or model process, that will enable consistency in course development as well as compliance to the ANSI/IACET requirements.

We will cover two modules (with integrated Activities) during the mini-tutorial. The first module provides background information on the ADDIE instructional system development model and the other provides *Application* examples for each phase in the ADDIE model. However, this paper integrates the *Applications* with each topic as it is covered. We have also organized the mini-tutorial modules directly around the five Learning Objectives stated on the first page. We will reflect on the Learning Objectives as we cover this ISD model and as we apply the model to our three case studies.

One of the key things to consider in all adult learning events is that adults often preview your objectives or abstract to determine if there is something in your session for them. They ask the question “what’s in it for me?” Adults juggle many priorities and their time is valuable. So, we can apply that concept, right now – why are you here? What is it in this particular session that you hope to get? What’s in it for you? Why are you reading this paper? During the mini-tutorial, we will take some time to reflect on what aspects of the session are most important for each participant.

To keep this session most applicable, we have selected three case studies and are relying on the subject matter experts (SMEs) from the committees responsible for the content to help us ensure the content meets the needs of the participants who might receive training. So, our design process overlays these educational design concepts onto the technical content. We hope that this approach will serve as a useful model for speakers who want to ensure that ideas they present are *applied* in the workplace and that committee members who want to develop training material based on the technical content in guides, standards, and recommended practices are able to *follow* these steps to be successful in creating effective training materials. Our number one goal in training materials is to be able to reach a designated level of *knowledge* or *application*.

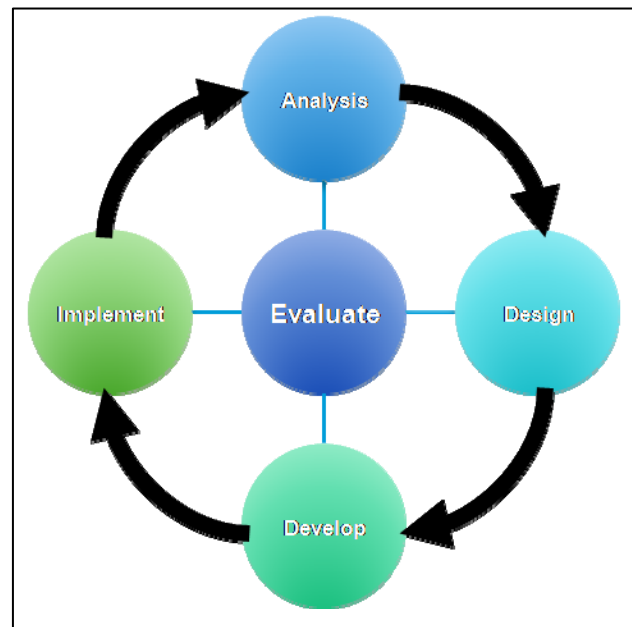
## ADDIE Instructional Design Model

There are many instructional system development models and you can see it graphically presented in a number of ways. The Laboratory Metrology Group of the Weights and Measures Division, National Institute of Standards and Technology (NIST) have chosen this particular approach because it follows a Plan, Do, Check, Act (PDCA) model with Evaluation forming a part of every phase. We will work through this diagram (See Fig. 2) and each of the phases, starting with Analysis. Every instructional designer ends up tailoring this model to his own processes, projects, and approaches to developing training. “One cardinal rule is to never leave out Analysis or Evaluation from the learning event development process because the projects can be spotted quickly – 1) these efforts seldom work to meet learning objectives and 2) no one ever really figures out why.”<sup>3</sup>.

There are a number of websites that cover Instructional Design concepts and the ADDIE model. Some additional references include:

- Hodell, Chuck, “ISD From the Ground Up, A No-Nonsense Approach to Instructional Design,” ASTD Press, August 2006.
- Elengold, Linda J., “Teach SMEs to Design Training,” ASTD Info-Line, Tips, Tools, and Intelligence for Trainers, 2001.
- Harris, Georgia L., “Development of a CD-ROM Metrology Course at NIST,” Measurement Science Conference, 2003. It is available here:

<http://ts.nist.gov/WeightsAndMeasures/upload/MSC2003CDROMPaper.pdf>



**Figure 2. ADDIE Instructional System Development (ISD) Model. ADDIE: Analysis, Design, Development, Implementation, Evaluation.**

## Defining the Audience and Need for Training

During the Analysis phase, the designer or, in most metrology cases, the instructor or SME defines the need, the target audience, and the expected outcome of the training. ANSI/IACET Criteria Number 4 is related to Learning Event Planning (4): “Each learning event is planned in response to the identified needs of a target audience.” There is room on the Case Study Planning Worksheet (Appendix A) and Learning Event Planning Worksheet (Appendix B) to make notes about the Audience and Need for a given training event.

As a first step in Analysis, we need to answer a number of questions:

- Who is the audience?

<sup>3</sup> Hodell, Chuck, “ISD From the Ground Up, A No-Nonsense Approach to Instructional Design,” ASTD Press, August 2006.

- Why conduct the training?
- What is the performance need?
- What is the root cause?
- How will the content be delivered and by whom?

We may need to answer these questions from the perspective of laboratory management as well as the metrologist or person being trained. We must have an effective partnership between the trainer, the manager, and the person being trained for the training to be effective and used/applied back on the job. If a manager does not support change that might be required for applying training content, the training will have no impact. Identifying the real need and the best solution are important for everyone.

One thing we might want to ask is: can other solutions meet the requirements without training? Sometimes when analyzing the need, we find that the root cause is lack of management support or lack of resources, rather than a lack of knowledge or awareness. Perhaps a simple publication and job aid such as a form or checklist serves an even better purpose than spending time in a training session. A step by step checklist or form may ensure consistent application of a new procedure, publication, or idea, without need for a training course.

If we look at the ANSI/IACET criteria for offering CEUs, one of the things we find is that we can also refer to a “job standard” to define the need for training. For example, any single item in the ISO/IEC 17025 standard for calibration and testing laboratories is rich as training content in the calibration world. One example might be a course on “Writing a Calibration Report (ISO/IEC 17025, Section 5.10.”

*Application: Identifying the Audience for our NCSLI Publications*

- The audience for the mini tutorial is primarily Committee Chairs and Members who want to develop training material from NCSLI publications. There might be additional benefits to regular conference presenters or tutorial instructors who want to improve the instructional value of their resources.
- The audience for RP 3, “*Calibration Procedures*” might be: Calibration Laboratory Managers, Metrologists/Engineers, Technical Managers, or the Procedure Writing/Validation Team.
- The audience for RP 20, “*Metrology Laboratory Workforce Planning*” and the “*Metrology Human Resources Handbook*” might include: Laboratory Managers, Human Resources staff, and Training Managers/Directors.

*Application: Examples of Need*

- The need for this mini-tutorial is that SMEs need formal training on methodologies and processes for developing training material from NCSLI publications to ensure compliance with standard training methodologies and the ANSI/IACET requirements.
- The need for training on RP 3, “*Calibration Procedures*” could include: a requirement in ISO/IEC 17025 to document calibration procedures and validate them.
- The need for training on RP 20, “*Metrology Laboratory Workforce Planning*” and the “*Metrology Human Resources Handbook*” include: a desire for international

consistency and adoption of standardized job descriptions to enable recognition and professional status of metrology careers.

## Learning Objectives

A Learning Objective or Learning Outcome (often interchangeably used), is a specific statement, written from the participant’s perspective, which provides information about what the participant will gain during a learning event. They are focused on participant performance, not teacher performance.

“Learning objectives: Statements about what a student will gain from a course or activity. These are specific statements about exactly what a student should know, be able to do, or value as a result of accomplishing a learning goal. Learning objectives form the basis for curriculum and course development as well as testing (Reed, 2005).”<sup>4</sup>

The “Bloom’s to Assessment” graphic (Fig. 5) and the Learning Event Planning Worksheet (Appendix B) are two tools that will help implement these concepts. They will help answer “what” and “why” of our learning event. Part of the Analysis phase helps determine what level of training and comprehension is required by the audience. Then, the Design process requires that we design training at the level needed to help the participant get what they need at the right level.

## Bloom’s Taxonomy

We will consider these six levels of understanding before we consider writing effective Learning Objectives. We need to answer what level we want the participant to be able to know and apply the material. We must accurately identify the audience, understand their level of knowledge, and their unique needs. Each of the six areas in the taxonomy builds on the previous level of knowledge. A key design and

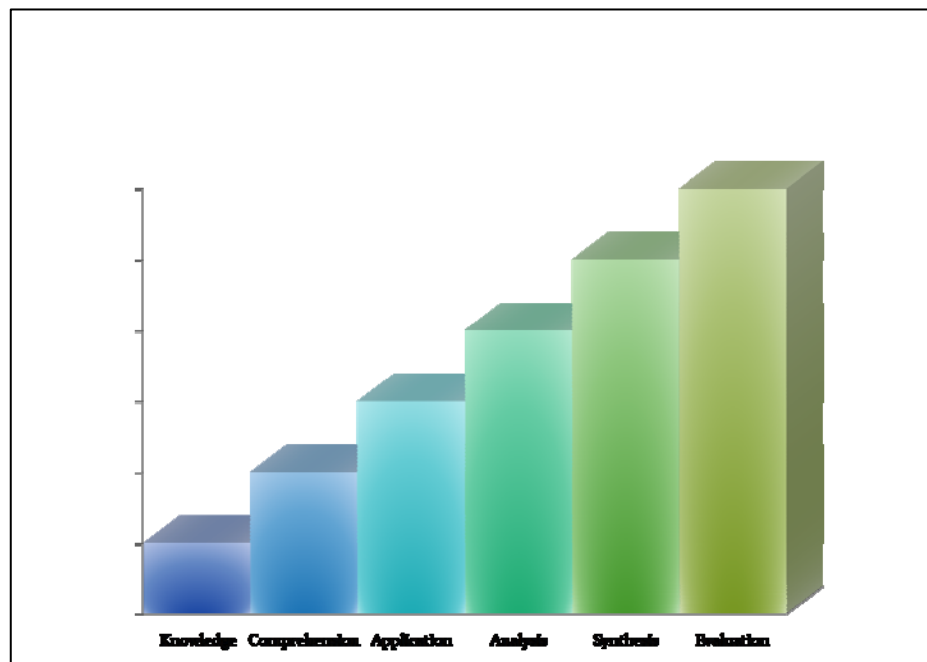


Figure 3. Bloom's Taxonomy Model.

<sup>4</sup>From the University of Texas at Dallas, glossary: [http://sacs.utdallas.edu/sacs\\_glossary](http://sacs.utdallas.edu/sacs_glossary) (March 2010).

development concept is that a participant must have Knowledge about a topic before they can Analyze it. In Table 1, the six areas noted in the Bloom's graphic (Fig. 3) are listed, with a brief description of each category, and a list of verbs that can be used to describe what the participant will need to be able to Know, Do, or Think after the session. These sample verbs provide examples that can be used to reflect appropriate learning levels in each Learning Objective and to specify the level of mastery expected for the student.

**Table 1. Bloom's Taxonomy - Descriptions and Sample Verbs.**

Level	Description	Sample Verbs
Knowledge	Recall data or information	describe, identify, recall, arrange, define, duplicate, label, list, memorize, name, order, recognize, reproduce state
Comprehension	Understand the meaning of a problem, be able to translate into own words	comprehend, give example, classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
Application	Use a concept in a new situation	apply, change, construct, compute, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
Analysis	Can split concepts into parts and understands the structure	analyze, break down, relate, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, make inferences, find evidence, test
Synthesis	Produce something from different elements (e.g., a report)	summarize, arrange, combine, categorize, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
Evaluation	Make judgments, justify a solution	appraise, interpret, argue, assess, attach, compare, defend, estimate, judge, predict, rate, core, select, support, value, evaluate, prove, deduct

### How to Write Learning Objectives

The ANSI/IACET standard for continuing education units identifies four categories in Section 5 related to writing Learning Objectives. These are the four criteria required for writing an effective Learning Objective.

1. They are written from the perspective of the learner, reflecting what the learner will achieve.
2. Learning objectives must be clear, specific, concise, and measurable (with four components):
  - a. They state the performance the learner should be able to accomplish. (Behavior)
  - b. They specify the conditions under which the learner is to perform. (Conditions)
  - c. They specify the criteria for acceptable performance. (Criteria)
  - d. They are directly related to the subject matter and content of the learning event.

3. Learning outcomes are established for each session within a large event, conference, or convention.
4. Instructional delivery includes discussion of learning outcomes.

If we expand on category number 2, and consider the four components of a clear, specific, concise, and measurable objective, here are some additional notes to clarify what is meant. Each Learning Objective should begin with: After this session (tutorial, paper, or workshop) the participant will \_\_\_\_\_.

Component 1: This component covers the expected behavior after the training. Think about performance in terms of active verbs related to what you want the participant to know, do, or be, after the training: identify, calculate, assess, present, analyze, and apply. (Refer back to Table 1 for additional examples.) At this point, select an appropriate verb for the level of knowledge or application that is expected.

Component 2: What are the conditions? Can the participant use their notes? Can they use a documented procedure? Can they use a calculator? Are computers allowed? Must they use Excel for calculations? Are there additional reference materials provided? Will they have to be assessed from memory?

Component 3: What criteria will be used to judge acceptable performance? Is an 80 % passing grade acceptable? Would it be okay if they submit their response in text-message format? Must they provide a written response or can it be oral? What will a valid uncertainty statement look like? (Instructors need to make sure that the criteria for successful performance are covered in the course!)

Component 4: Learning objectives must be directly related to the subject matter and content of the event. If you haven't covered various types of statistical distributions in a course, you should not evaluate students against the criteria (unless of course it was given as a prerequisite). If a course is to cover how to correctly perform pressure calibrations, it would not make sense to have Learning Objectives related to the laboratory management system. This component should be obvious – but must be stated.

Another approach commonly used is the A-B-C-D approach to writing Learning Objectives. A, B, C, and D stand for Audience, Behavior, Condition, and Degree. This approach matches up nicely with the ANSI/IACET criteria, in that the objective must focus on the Audience, and be written from the student perspective. Then, it needs to specify what Behavior is expected as a result of the training, must address the Conditions that will be allowed, and the Degree or level of mastery required (the Criteria for measuring successful mastery). We may not use this model in this tutorial, but you might see it in some references on this topic and the approach may be helpful to you.

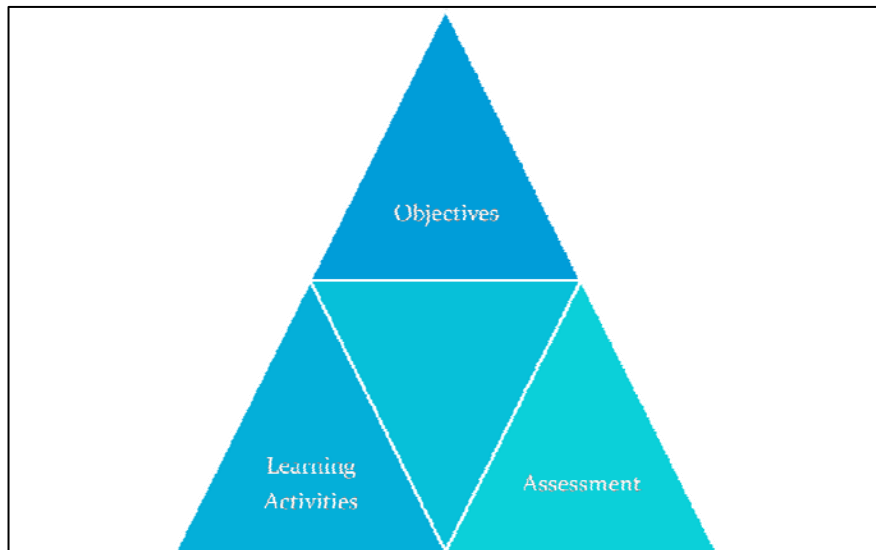
Developing Learning Objectives for our *Application* examples are next. You can see that we have included the Behavior, Condition, and Criteria in these examples. Note how you might improve or expand on ideas for appropriate Learning Objectives.

*Application: Examples for NCSLI Publications*

- Five Learning Objectives for this mini tutorial were stated earlier on page 1.
- Objectives for RP 3, “*Calibration Procedures*” might include: given resources and examples (*condition*), participants will be able to correctly (*criteria*) write, assess (identify good procedures, identify gaps and weaknesses), and validate procedures (*behavior*).
- Objectives for RP 20, “*Metrology Laboratory Workforce Planning*” might include: given the resources (*condition*), participants will be able to describe the overall workforce planning process (*behavior*), and successfully implement all or portions of (*criteria*) laboratory succession planning efforts (*behavior*), etc.
- Objectives for the “*Metrology Human Resources Handbook*” might include: given the resources (*condition*), participants will be able to update job descriptions (*behavior*) consistent with standard practice (*criteria*), collect employment data (*behavior*) according to standard classifications (*criteria*), participate in providing input to OPM/Department of Labor, etc.

### **How to Select and Align Activities and Assessments with Learning Objectives**

The triangle shown in Figure 4 represents the relationship between Learning Objectives, Learning Activities and Assessment. If these three components are present and compatible then teaching and learning is enhanced, hence, this model is often called “The Magic Triangle.” If these three components are not congruent then students become discouraged and unhappy and make the assumption the objectives cannot be trusted and they will stop paying attention to them. A key factor to consider with this model is that if one side of the triangle is missing, the learning collapses and is not effective.

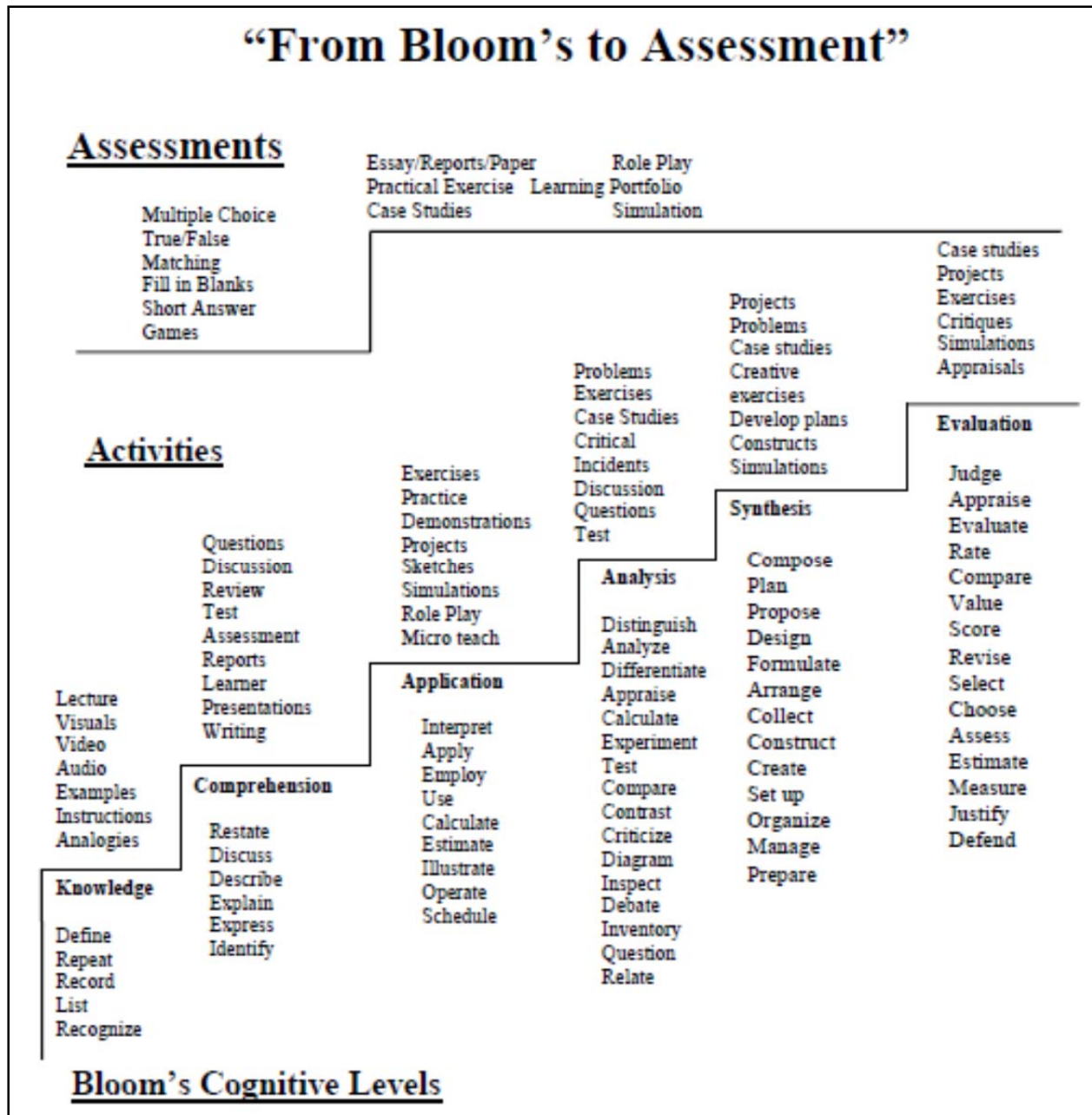


**Figure 4. "The Magic Triangle." Used to align Learning Objectives, Activities, and Assessment Methods.**

Note: Learning Activities are those things the instructional designer plans during the Design Phase and the student does to learn in the Implementation Phase. For example, listening to a lecture is a Learning Activity; engaging in a small group discussion led by a facilitator is a Learning Activity; evaluating a measurement instrument with a calibration technician clinician is a Learning Activity.



Evaluation or Assessment (of the student, not the course) is often thought of as a *testing* component. But, Assessment could also be a project assignment that is graded or otherwise evaluated. The important factor to consider is that whatever forms the Assessment takes, it



should measure the student’s accomplishment and provide specific feedback to the student(s) on how well they met the Learning Objectives.

**Figure 5. From Bloom's to Assessment.**

If you review the “Bloom’s to Assessment” graphic (Fig. 5), you can see that there are some activities more appropriate for some levels of learning than others. E.g., a Lecture/Test might be appropriate Activity and Assessment for the Knowledge level learning, but it is usually the lowest level of engagement and retention. A Case Study Activity and Assessment are more appropriate for the Application and Synthesis levels. The concept of the Magic Triangle (Fig. 4)

should be considered when using the Learning Event Planning Worksheet (Appendix B) that we will also discuss later. Keep this idea in mind: the Objective, Activity, and Assessment components are all a part of the triangle, all are essential, and all must be considered during the Design process. They must be selected to match the appropriate level of Bloom's taxonomy.

### **Designing Content**

ANSI/IACET Criteria 7 states that: the content and instructional methods are appropriate for each learning outcome; content is organized in a logical manner in support of learning outcomes; instructional methods are consistent with learning outcomes regardless of delivery mode; and instructional methods accommodate various learning styles and are designed to promote interaction between and among learners, instructors, and learning resources to achieve the stated learning outcomes.

Depending on what topic is being converted to training material, a trainer might design around themes, chronology, or steps in a measurement process. It is important to make sure that topics are aligned around the objectives and to focus on ensuring that the technical content is effective as training material. Using a logical sequence of topics is one of the ANSI/IACET criteria and is important for training course development. One topic should typically build on the knowledge gained from previous topics or modules.

In this mini tutorial we are taking PowerPoint®<sup>5</sup> slide content that is “about a publication” and converting it to a “training resource.” If the content were not available, we would have to start from scratch and design and build everything. Our focus is to convert the content in such a way as to comply with recognized ISD education and training models.

Techniques, teaching methods, or activities need to be selected and aligned for each of our Case Studies to match the Bloom's Taxonomy level we want to achieve, as well as the KSA (Knowledge, Skill, Ability) we are trying to ensure the participant can KNOW or DO at the conclusion of the session. What are the best instructional methods that are likely to be used during the Implementation phases? Instructional designers must think about best instructional and Assessment methods during Analysis and Design to select the best activities and methods for teaching. They must also consider the best Assessment methods. Table 2 lists several examples of Teaching Activities/Methods.

A traditional model of training that combines Activity and Assessment is Lecture, followed by a Test. In a conference setting, we often only see Lectures. As you can see by reviewing the “Bloom's to Assessment” graphic (Fig. 5), this approach is not very effective if you want participants to know or do something different. What makes it worse is that adults prefer to be involved in their learning and tend to hate the Lecture/Test model. What comes to mind is “death by PowerPoint!” This approach provides the lowest level of engagement and retention and treats the audience as inexperienced/non experts (though they usually do bring *something* to the learning event). During the Analysis and Design phase we must answer whether we want people to only be able to LIST information or be able to fully ANALYZE and APPLY the material on

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<sup>5</sup> The use of specific software products is not intended as an endorsement; it is simply the products that are commonly used in the development of training resources.

the job. In most cases, we want to see performance improvements on the job and not simply improve a participant's knowledge.

**Table 2. Teaching Activities/Methods.**

Activity or Method	Description
Lecture	Presents factual material in a direct logical method. Useful for large groups. Should only be used in combination with other instructional techniques, unless there is a very inspirational instructor and the goal is to inspire learners. Lectures must include liberal use of visual, auditory, and kinesthetic (physical activity) approaches. Lectures are often passive and learning is generally at the lowest end of Bloom's taxonomy.
Video	Can be entertaining if selected and done well. Video can be used as part of an Activity, but additional instructions need to be included, such as "watch this video and take notes on the measurement errors you observe."
Discussion	Discussions are often started by asking open ended questions and engaging all participants. They can be done in large groups, small groups, or as brainstorming sessions. The idea is to engage all participants. It is not practical for very large groups unless there is an option for breaking into smaller groups and reporting back.
Demonstration	In this method, the instructor or a member of the class might demonstrate a procedure or method to the rest of the class. Participants are given an idea of what something might look like in practice and have the opportunity to observe, ask questions, and critique.
Exercise/Drill	Perform a measurement procedure or review a specific procedure is an example of an exercise/drill activity. Exercises provide immediate opportunities to apply what has been learned. Students individually perform an experiment and then come together as a class to discuss the results. The hands-on application of a procedure and final expected results are often assessed.
Case Study	Case studies are practical examples related to the content that must also be relevant to the participant. Allows for application of content that has been learned and promotes analytical and problem solving skills. The case study must be complete enough for the participant to assess the entire case versus having too many unknown components that might simply frustrate the students (especially if the right answer is more fixed than students are led to believe).

*Application: Selecting Activities*

To convert our technical content to training materials, we need to have some creative planning. Having a team of designers or instructors select energetic and applicable Activities can be an art. This phase is often quite a challenge for no-nonsense SMEs for whom the content is obvious and comes easily. During the design process we need to answer: What kind of activities will help participants understand, implement, analyze at the levels needed? We have selected some Activities for our Case Studies below. Can you identify additional Learning Activities that might be fun, engaging, and effective?

- Activities for this mini tutorial. We are making extensive use of real case studies from new NCSLI publications. These provide real examples of what we are trying to do.

- Activities for RP 3, “*Calibration Procedures*” might include: provide a procedure with parts missing – identify missing parts and consider the impact if they are not present; provide a procedure that is poorly written or unclear and consider the impact; provide a well written procedure, and consider what is needed to document the validation.
- An Activity for RP 20, “*Metrology Laboratory Workforce Planning*” might include: perform a knowledge/skills/ability Assessment for participants (make it real for each person) to answer the question, what would be required for succession planning to fill your own position.
- An Activity for the “*Metrology Human Resources Handbook*” might include: bring your own set of job descriptions to the course to assess them against the Handbook criteria.

### **How to Ensure Learning Takes Place–Assessments**

Activities and Assessment methodologies must be considered in the context of Design, but the instructional designer must consider how they will be Implemented for each audience. The ANSI/IACET Criteria 8 specifies that Assessment must take place. Procedures established during event planning [Design, Development] are used to assess student’s achievement of the learning outcomes. Learners must also be provided feedback on their mastery of learning outcomes. During development we will develop the instructional content, but we must consider good design approaches in the Design phase. Later, Implementation also includes the Activities, and Assessments of whether students have mastered the topic at the expected or desired level.

It is important to align the Assessment method with the Learning Objective and Activity as shown in the Magic Triangle (Fig. 4) and the “Bloom’s to Assessment” graphic (Fig. 5). For adult audiences, it is important to integrate Assessment into the training as much as possible (versus issuing a post-test). According to the ANSI/IACET criteria, each person does not have to be assessed on achieving each objective in a course, but sometimes that is important for issuing certificates of successful completion or for demonstration of competency. For example, if you have objectives such as “each person will successfully calculate the standard deviation and get 100 % correct” or “each person will successfully calibrate item x during the seminar.” In those examples, the instructor will need to be able to review each person’s numbers or measured result to assess accuracy and achievement of the objectives, and also to provide feedback to the student. Sometimes there is also a need to assess post-event learning and application – e.g., use of proficiency testing for procedure training.

To improve Assessment efficiency, and to motivate and engage students, it is important to provide group feedback to let them know what you learned from the Assessments and what difference that information will make. All Assessments need to reflect back to measurable Learning Objectives to determine if the student has learned the material and it is important to provide feedback to the student so that they know whether they have learned the material correctly. That is, Assessment should be more than simply correcting a quiz and returning it with a grade. Table 3 provides a number of Assessment Methods that may be considered.

**Table 3. Assessment Methods.**

<b>Assessment Method</b>	<b>Description</b>
Multiple Choice	A type of quiz or Assessment where the student must choose either the best answer or a number of answers that might be correct. Immediate review can be done to provide feedback. Discussion of “wrong” items often yields interesting applications that might not have been considered during the Analysis, Design, and Development phases.
True False	This is a simple type of quiz or Assessment that can be done orally or on paper. It can be done individually or in a large group setting. Right and wrong answers are usually provided. It can be done by raising of hands. E.g., how many of you think this statement is True? How many false? Can anyone give me a reason for their answer? Feedback might be as simple as “great job” or “here’s the correct answer.”
Fill in Blanks	This type of approach can be done in a group setting and handled orally, or even in teams. Most often it is used in a written test and will usually only have one right answer.
Essay/Reports	It is more difficult to assess essays/reports in a training session unless it is several days long and the instructor will have time to review and grade the content. Specific guidance may be needed in the Developed material to ensure that an instructor or facilitator knows the content adequately or has adequate information on which to base evaluation. A “one minute” Assessment can also be useful. For example, “write down one thing you learned [and can apply] during this session on this index card and pass it in.”
Simulation	The Assessment is made in each participant’s engagement, completion, and accuracy of the Learning Objectives and at the level of knowledge required. Job task analysis can help create an observational checklist.
Case Study	The application of a procedure and final expected results are often assessed. Group review of the final results can provide dynamic feedback or individual feedback may be provided to each participant. Teachers can use a checklist and observation to assess student success with the particular material. A minimum set of knowledge or skills can be included on the checklist. Job task analysis can help create an observational checklist.
Role Play	Specific guidance is given to the parties in the role play and then observations and feedback from the group are collected. The instructor provides an overview of the Activity and summarizes the important components. Participants are encouraged to practice a role or skill. Teachers can use a checklist and observation to assess student success with the particular material.
Journaling	Students are asked to take specific notes during the session. For example, “write down one key idea from this session and write down one thing you can apply back on the job.” The summary notes are reviewed at the end of the class either as a group or individually. The notes can also be used to summarize or highlight the important aspects of what was learned to a manager or coworker back on the job.

The Case Study Worksheet (Appendix A) and Learning Event Planning Worksheet (Appendix B) use tables that can be expanded like the one shown in Table 4. These worksheets can be using during the Design phase to consider effective methods in training resource development. But, this specific portion of the worksheets (Table 4) helps align the Learning Outcomes with the Activities and Assessment methods to ensure that all three sides of the Magic Triangle (Fig. 4) are aligned according to the “Bloom’s to Assessment” (Fig. 5) and that the instructional materials and methods will be effective. If Assessments are integrated into the Activity effectively, students may not realize whether they are learning or being assessed.

**Table 4. Example Learning Outcomes, Instructional Methods, and Assessment Methods.**

Item	Learning Outcome	Instructional Method (Activity)	Assessment Method

*Application: Matching Assessments to Activities and Learning Objectives*

- Activities and Assessment for this mini tutorial. We are making use of real case studies and reviewing possible *Applications* as we cover each Phase. Assessment will be done by evaluating the levels of participation and questions raised by participants. Feedback will be given during the session. Follow up Assessment will be done to determine the level at which new training materials comply with the ADDIE model and ANSI/IACET criteria.
- Activities for RP 3, “*Calibration Procedures*” might include: provide a procedure with parts missing – identify missing parts and consider the impact if they are not present; provide a procedure that is poorly written or unclear and consider the impact; provide a well written procedure, and consider what is needed to document the validation. In this case, was the participant able to identify missing items in a calibration procedure? This could be done through group discussions and a presentation with feedback from the facilitator. Assessing impact would be much more difficult as an Activity and one might question whether there is a list of key items one might consider in assessing the impact of poorly written calibration procedures. The content of the Assessment material must be covered in the training.
- An Activity for RP 20, “*Metrology Laboratory Workforce Planning*” might include: perform a knowledge/skills/abilities Assessment for participants (make it real for each person) to answer the question, “What would be required for succession planning to fill your own position?” If an Activity included discussion of each phase in Succession Planning, and the Learning Objective was to list three of the five phases, an oral examination, or team competition, might be used to assess whether the participants understood the topic at the level expected.
- An Activity for the “*Metrology Human Resources Handbook*” might include: bring your own set of job descriptions to the course to assess them against the Handbook criteria. However, the objective might have been to be able to list the three job titles

that are in the handbook. In that case, a quiz at the end could determine if the participant is able to list all three job descriptions. A matching quiz could be used to match attributes with each job title.

### **Developing a Lesson Plan, Agenda, Instructor's Resources**

Once the course content is Designed, the course materials are Developed. Content that is developed might include an Agenda, Lesson Plan, Slides, Visual Aids, and Instructors Notes. It should also include any additional handouts or case study references that are not included as a part of the course reference materials. For example, in this mini-tutorial, we provide: a copy of this paper, copies of PowerPoint slides from the three Application examples, and additional References on a CD-ROM. We are also providing a set of PowerPoint slides (Notes version) and a paper copy of Appendix A for personal notes during the session. We are intentionally providing the Notes version because our time will be limited and we want to encourage participants to share this resource within their committees or with others who are developing training resources. Our goal is to encourage participants to implement the content at the Application level of Bloom's Taxonomy. You will note that this goal was not stated as a Learning Objective, but is an outcome of the training that we hope will be fulfilled.

The agenda for the mini-tutorial includes:

- **Overview of the Session** (including Learning Objectives). We will ask participants to take notes on their own project or use the Case Study we will discuss.
- **Module 1: ADDIE ISD Process/Theory**. This is presented as Lecture with Group Oral Assessment.
- **Module 2: ADDIE Process – Applied to One Case Study** (the RP on Calibration Procedures). (Note: this paper provides references to three Applications, but there is not time to cover all three examples during the session; however they are included in the Notes section of the slides/handouts.) The Five Steps of Adult Learning (Metrologist, July 2010) will be implemented as a part of the teaching/Activity. Assessment will include review of participant engagement. Are the questions applicable? Are groups interacting? Are new, creative ideas raised?

For a mini-tutorial that is presented in one and a half hours, we are not planning for any breaks. However, we want to cover the Overview and Module 1 fairly quickly so that we can ensure we spend the majority of our time on the *Applications* (Case Study). An estimated time might be 15 minutes for an Introduction and Overview, 30 minutes for Module 1, and 45 minutes for Module 2.

In general, PowerPoint® provides a Notes section that can be used for instructor guidance and reference. During the Development, and Implementation phases, it is important to ensure that the notes and content are enough for a knowledgeable and skilled instructor or SME to present the content. What else might be needed? Are the case studies included? Will there be a compiled handout for participants as well as instructors? What qualifications are needed (if any) for the instructor/facilitator? The instructor must have a background in the instructional design process, but because the process is fairly simple and the notes fairly complete, a good instructor could feasibly review the materials and facilitate the implementation with knowledgeable SMEs. In

fact, the content for this mini-tutorial could easily be shared by an effective Committee Chair to the rest of their Committee to guide the development of new training resources.

### **Implementation and Evaluation**

Implementation and Evaluation are the last two phases of the ADDIE model. It is arguable that Evaluation is last because we integrate it into each level of the process. It is beneficial to conduct dry-run evaluations and obtain feedback (beta testing) with instructors or SMEs to ensure the needs and objectives of the training material will be met. Adjustments in the content will often be made as the material is developed – and before the course is presented. Course evaluations and continual improvement (refinement) of content, objectives, activities, and Assessments also help to improve content over time.

Having an evaluation program that includes overall assessment of all program components, as well as individual course evaluations, is an essential part of the ANSI/IACET criteria, but we will not spend time on those phases during the mini-tutorial. This is not to minimize their importance as a part of the ADDIE process as much as it is related to the need to focus on Designing and Developing content in the available time. Recall what we said earlier: a cardinal rule is to never leave out Analysis or Evaluation from the learning event development process because the projects can be spotted quickly – 1) these efforts seldom work to meet learning objectives and 2) no one ever really figures out why.”

### **Conclusions**

This paper is being presented as part of a mini-tutorial to help metrology subject matter experts design and develop training content that follows formal ISD models and to help comply with ANSI/IACET standards for Authorized Providers in NCSLI-developed training resources. The authors hope that this resource will be expanded and enhanced for use by NCSLI committees in the Analysis, Design, Development, Implementation, and Evaluation of training resources as well as used as a resource for converting or developing effective metrology training content.

### **Acknowledgements**

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### **Appendices and References**

- Appendix A: Case Study Planning Worksheet
- Appendix B: Learning Event Planning Worksheet
- Metrologist Articles: CEU (April 2009), Train the Trainer: Writing Learning Objectives (April 2010), 5 Steps for Adult Learning (July 2010), Activities and Assessments (October 2010, draft)
- NCSLI Website: Trainer Resources:  
[http://www.ncsli.org/NCSL/learning/Trainer\\_Resources.aspx](http://www.ncsli.org/NCSL/learning/Trainer_Resources.aspx)



## Appendix A

### Case Study Planning Worksheet

Title of Course/Tutorial: \_\_\_\_\_

<b>ADDIE Phase</b>	<b>Questions and Notes</b>									
<b>Analysis</b>	<p>What is the need?</p> <p>Who is the audience?</p> <p>What standards might be referenced?</p> <p>What will success look like?</p>									
<b>Design</b>	<p>Write Learning Objectives:</p> <p>Using _____, participant will be able to _____ (at this level _____) after the training.</p> <p>Level in Bloom's Taxonomy?</p> <p>Possible VERBS?</p> <p>Match Activity – Align Assessment Method What are some possible activities and Assessments that can be used?</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr> <th style="width: 33%;">Learning Objective</th> <th style="width: 33%;">Activity</th> <th style="width: 33%;">Assessment</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>Tools: Learning Event Planning Worksheet, "Bloom's to Assessment", Writing Learning Objectives Article</p>	Learning Objective	Activity	Assessment						
Learning Objective	Activity	Assessment								
<b>Develop</b>	<p>Creating content... Teacher's Manual. Slides. Case Studies. Often slides.... (or outline/notes)</p> <p>Additional handouts? Worksheets? Case studies?</p> <p>Additional considerations: Instructor notes. Agenda. Lesson Plan. Timing/breaks. Constraints.</p>									
<b>Implement</b>	<p>Step 1: Set up the Activity. Step 2: Conduct the Activity. Step 3: Learners share and interpret their reactions. Step 4: Participants identify concepts. Step 5: Participants consider and share how they will apply these concepts.</p> <p>Tools: Five Steps of Adult Learning</p>									
<b>Evaluate</b>	<ol style="list-style-type: none"> <li>1. Evaluate each phase of the ADDIE process.</li> <li>2. Participant Assessment Methods.</li> <li>3. Use of standard course evaluations.</li> </ol> <p>Tools: Learning Event Planning Worksheet, "Bloom's to Assessment"</p>									

## Appendix B

### Sample Learning Event Planning Worksheet (used for Analysis and Design Phases)

**Title:**

**Abstract:**

**Constraints:**

- Instructor:
- Time/Date:
- Length of course:
- Prerequisites: (e.g., previous course, downloadable reading, tasks/activities)
- Maximum number of students:
- Minimum number of students:
- Room set up:
- AV Required:

**Define the audience and need for this training** (e.g., laboratory management knowledge, skill, ability, standards such as ISO/IEC 17025, 17043, VIM, GUM, measurement parameter knowledge, skill, ability to perform calibrations, poor performance on proficiency tests, observed/requested needs):

**Complete this table for each course/event:**

<b>Learning Objectives<sup>6</sup></b>	<b>Instructional Method (Activity)<sup>7</sup></b>	<b>Assessment Method<sup>8</sup></b>

**Agenda Outline** (Include highlight agenda items and attached detailed agenda and descriptions.)

<b>Topic</b>	<b>Time</b>
Attendance, Group Introductions	
Course Title, Description, and Successful Completion requirements	
Learning Objectives	
Module 1 Objective, Activity, Assessment	
Module 2 Objective, Activity, Assessment	
Module 3 Objective, Activity, Assessment	
Review and Closure	
Course and Student Assessments	

<sup>6</sup> Note Bloom’s Taxonomy and write from the Learner’s perspective... E.g., At the end of this session, the learner will be able to use “x” tool to comply with section “y” of “q” standard; will be able to name the benefits of complying with the standard; will be able to tell others how to select the best tools from choices given to implement a program. This is NOT where the instructor says “here’s what we’re going to cover.” Suitable activities and Assessment methods are to be used to ensure participant learning at the desired level.

<sup>7</sup> Think about Instructional methods and Learning activities. What are the Visual activities: observing slides, watching list of notes, demonstrations of documents, watching a measurement, watching a video, reading a procedure. What are the Auditory cues: lecture, discussion, question/answer, round the room sharing, brainstorming, and role playing? What are the kinesthetic activities: making a measurement, taking time to reflect and write notes – journaling; sharing thoughts; reviewing and summarizing a document; note taking that includes key questions (and can be used for learner Assessment). Activities must be matched with Assessment method and Learning Objectives.

<sup>8</sup> Think about how to provide immediate Assessment and feedback to adult learners and consider the Five Steps of Adult Learning. After a question directed to the group (whether they answer aloud or in writing), provide the right answer. Use a quick daily/hourly Quiz. Use a Q&A approach and provide answers. Ask individual participants to share their answers or examples. Use a competitive game. Use role playing and have participants provide feedback to each other. Give immediate feedback when creating a group list by brainstorming.